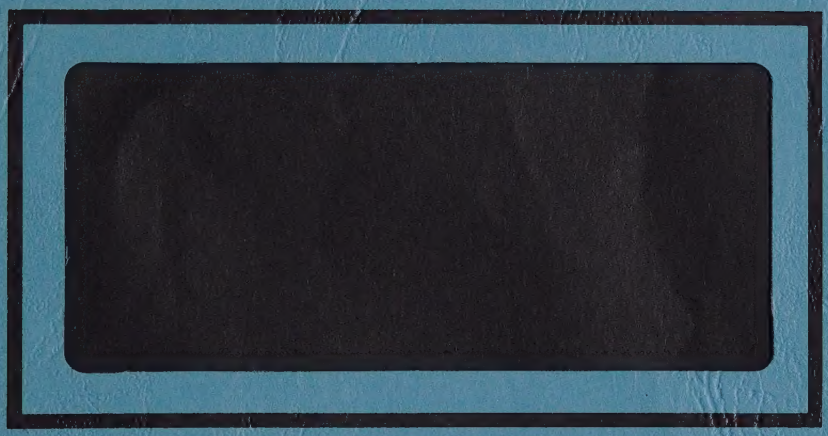

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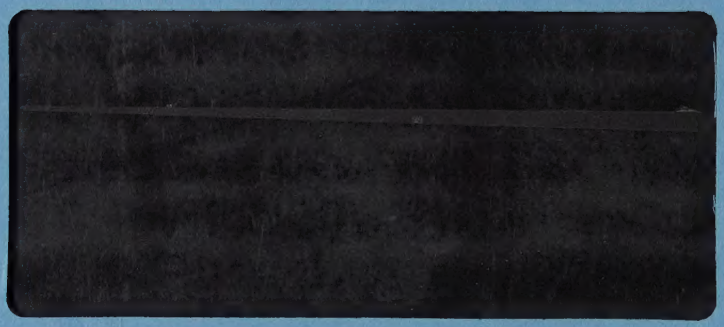
electronics, inc.



Recd 2-19-71
from Bill W.

Model 500, 503, 504, 505

function generators

INSTRUCTION MANUAL

MODELS 500, 503, 504 and 505 FUNCTION GENERATORS

EXACT ELECTRONICS INC.
455 S.E. 2nd Avenue, Hillsboro, Oregon 97123 • TEL: (503) 648-6661

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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.

2. Check fuse and power supply voltages.

3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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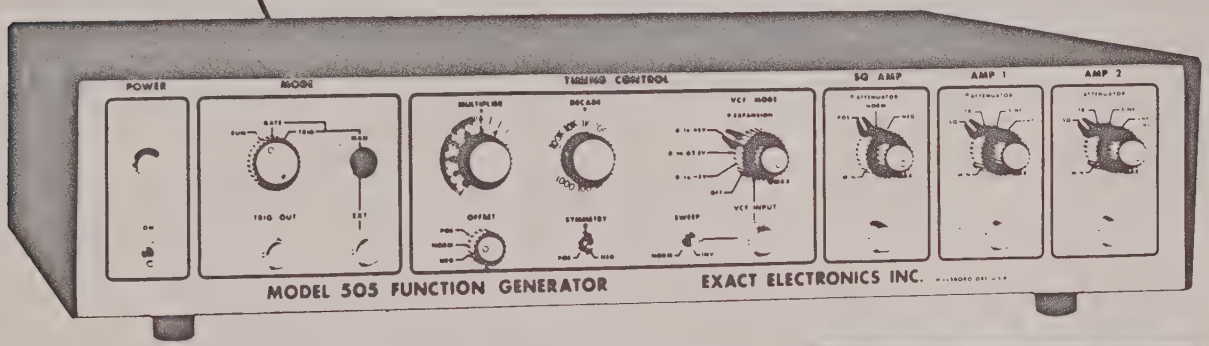
SECTION 2

CHARACTERISTICS, SPECIFICATIONS

EXACT electronics, inc.

Function Generators • Waveform Synthesizers

MODELS 503, 504 and 505 FUNCTION GENERATORS



503, 504 and 505

Take these signals:

503, 504 and 505

push-pull them:

504 and 505

single-shot or gate them:

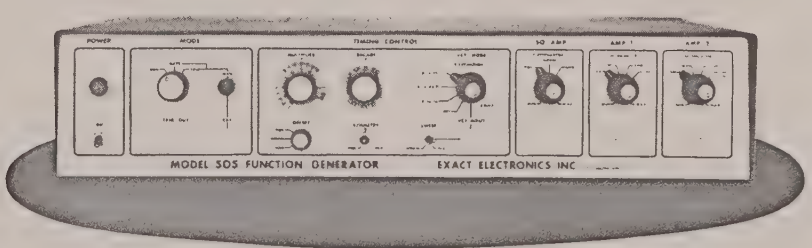
503 and 505

add VCF at 50:1

503	$525
504	$525
505	$595

Prices effective 1 April 1968

Prices and specifications subject to change without notice.



You can have all this in our 505

EXACT Electronics, Inc.

EXACT ELECTRONICS INC.

455 S.E. 2nd Avenue, Hillsboro, Oregon 97123 • TEL: (503) 648-6661

503, 504 AND 505:

OUTPUTS: Three selectable, continuously variable

SQ. AMP

Square: 25V P-P into 600 ohms, 50nsec risetime
Positive square: 0 to 13V P, 50nsec risetime
Negative square: 0 to −13V P, 50nsec risetime

AMP 1

Triangle: 25V P-P into 600 ohms
Sine: 25V P-P into 600 ohms
Ramp: 25V P-P into 600 ohms
Square: 25V P-P into 600 ohms, 50nsec risetime

Positive triangle, square or ramp: 0 to 13V P into 600 ohms
Negative triangle, square or ramp: 0 to −13V P into 600 ohms

AMP 2

Same outputs as AMP 1 with 180° phase shift. Also has provision to put AMP 1 and AMP 2 in phase. Square wave risetime out of AMP 2 is 100nsec.

All three amplifiers are short circuit proof and will drive 50 ohms at reduced amplitudes, approximately 5 volts peak to peak.

FREQUENCY RANGE: .0001Hz to 1MHz in ten decade ranges

FREQUENCY ACCURACY: .0001Hz to 1MHz ±3% of dial reading

FREQUENCY STABILITY: ±0.025% short term (10 min.)
±0.2% long term (24 hr.)

AMPLITUDE STABILITY: ±0.1% short term (10 min.)
±0.25% long term (24 hr.)

DC REFERENCE STABILITY: ±0.05% short term (10 min.)
±0.5% long term (24 hr.)

DC REFERENCE: Amp 1 and Amp 2 0 volts ±50mv
Sq. Amp 0 volts ±75mv

SINE DISTORTION: Less than 1% to 100K, Less than 2% to 1MHz

AMPLITUDE FREQUENCY RESPONSE: ±0.1db .0001Hz to 100KHz
±0.5db 100KHz to 1MHz

TRIANGLE, RAMP LINEARITY: 99% to 10KHz, 98% to 1MHz – Ramp to 100KHz

VCF RANGE (503, 505 only): 50:1

VCF LINEARITY (503, 505 only): 20:1 ±0.1%, 50:1 ±2%

The VCF input will accept three different inputs: 0 to +5V, 0 to −5V, 0 to ±2½V.

504, 505 ONLY:

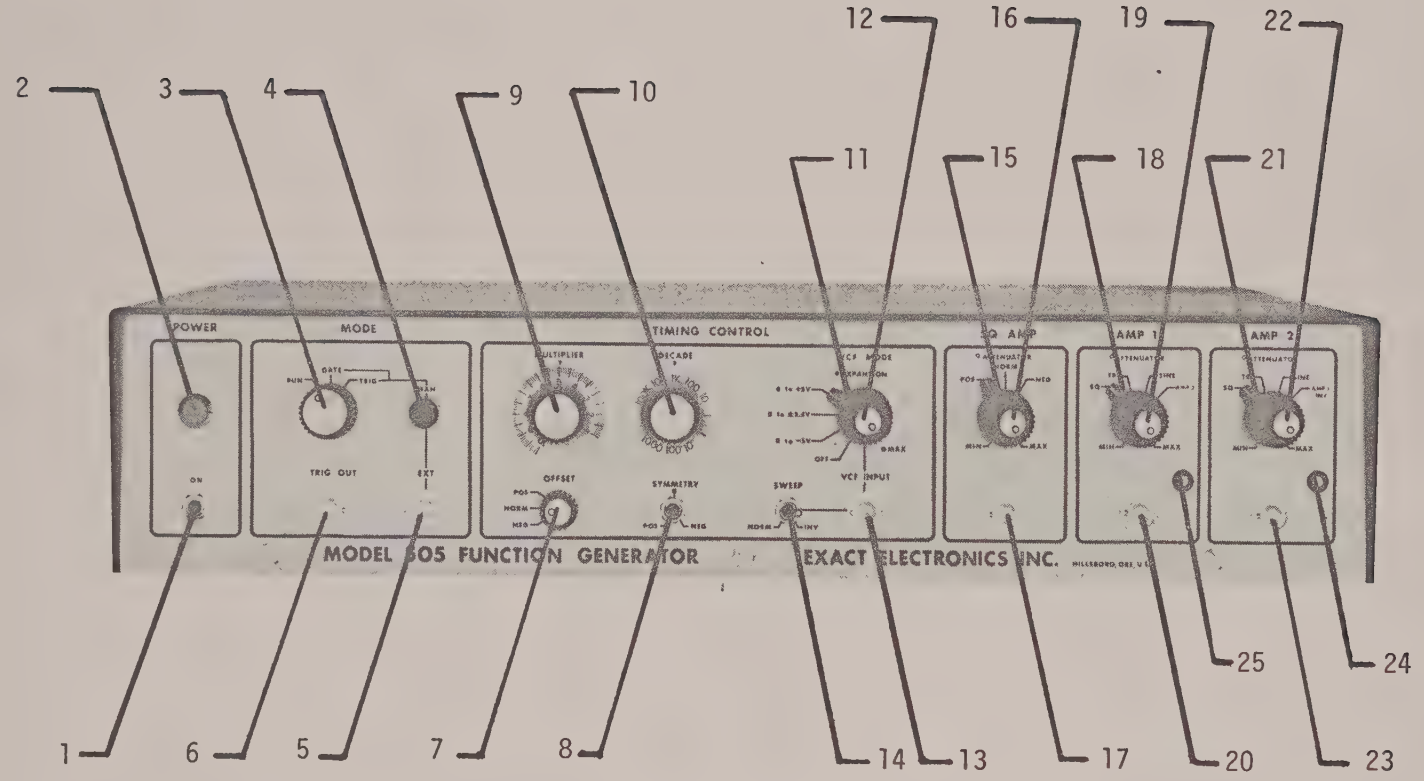
GATE TRIGGER INPUT: Manual or External, +5V turn ON, approx. +2V turn OFF. Gate D.C. coupled, trigger A.C. coupled.

Trigger Mode requires a pulse of at least 1 usec rise-time to trigger on.

PHYSICAL SIZE: 16¾" wide, 3½" high, 14¾" deep

SECTION 3

FRONT PANEL CONTROLS, OPERATING INSTRUCTIONS, FIRST TIME OPERATION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POWER
MODE
TIMING CONTROL
SQ AMP
AMP 1
AMP 2
ON
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EXT
OFFSET
SYMMETRY
SWEEP
VCF INPUT
MODEL 505 FUNCTION GENERATOR
EXACT ELECTRONICS INC.
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3.0.0 . . . . . OPERATING INSTRUCTIONS

3.1.0 FRONT PANEL FAMILIARITY

3.1.1 Location and Function of Controls

1. Power on/off switch
2. Power ON light indicator
3. Gate/Trigger/Free Run mode selector switch.
4. Manual Gate/Trigger pushbutton
5. External Gate/Trigger input jack
6. External Trigger output jack for triggering external equipment
7. Offset control - provides either positive or negative offset from ground for triangle, ramp or sine out of amplifiers 1 and 2.
8. Symmetry switch - used to convert triangle into a ramp or square wave into a pulse
9. Multiplier dial - multiplies decade frequency
10. Decade selector switch - selects any one of ten decade ranges.
11. VCF input mode selector - selects one of three voltage controlled frequency inputs. Selection depends on what type of voltage is available.
12. VCF expansion control - variable sweeping range adjustment. Full maximum gives 50:1 sweep with +5V, -5V or ±2½V ramp VCF input.
13. VCF input jack
14. VCF sweep direction selector - selects direction of sweep with any given input voltage. Example, in Norm position with a plus ramp input, generator will sweep down in frequency from dial setting. In the Inv position with same plus input voltage, generator will sweep from low end of sweep range (50:1 lower than dial setting) up to expansion ratio set by expansion control. Refer to section 3.3.13 for sweep control characteristics when VCF mode selector switch is in the 0 to -5V and 0 to ±2½V positions.

3.1.1 Location and Function of Controls (continued)

15. Square amp selector - selects bi-polar square, positive square, negative square. Also selects bi-polar pulse, positive pulse and negative pulse if Sym switch is either Pos or Neg.

16. Square Amp attenuator - attenuates output from max amplitude down to approximately 0. Below 100mv refer to Section 2, Amplitude Adjustment.

17. Square Amp output connector

18. Amplifier 1 selector - selects square, triangle, sine or Amplifier 2. Also selects ramp, reverse ramp and pulse if SYM switch is positive or negative. Amp 1 selector to Tri for ramp, square for pulse.

19. Amplifier 1 attenuator - attenuates outputs from maximum amplitude down to approximately zero volts.

20. Amplifier 1 output

21. Amplifier 2 selector - selects square, triangle, sine or Amp 1 inverted. Also selects ramp, reverse ramp and pulse if Sym switch is Pos or Neg. Amp 1 selector to Tri for ramp or square pulse.

22. Amplifier 2 attenuator - attenuates output from maximum amplitude down to approximately zero volts.

23. Amplifier 2 output connector

3.2.0 FIRST TIME OPERATION

3.2.1 A. Set all function generator controls as follows

POWER	ON
MODE	RUN
OFFSET	NORM
SYMMETRY	OFF
MULTIPLIER	X10
DECADE	1K
SWEEP	NORM
VCF MODE	0 to +5V
VCF EXPANSION	MAX
SQ AMP	NORM
AMP 1	SQ
AMP 1 ATTEN	MAX
SQ AMP ATTENUATOR	MAX

3.2.1 A. Function Generator controls (continued)

AMP 2	SQ
AMP 2 ATTEN	MAX
TRIG OUT	Connect trig out jack to monitor oscilloscope external trigger input. Use coaxial cable.

B. Set oscilloscope as follows.

VERTICAL SENSITIVITY	5V/CM
INPUT COUPLING	DC
SWEEP TIME	100μSEC/CM
TRIGGER	EXTERNAL POS

3.2.2 Procedure for producing bi-polar square

A. Same settings as in 3.2.1.

B. Monitor square amp output. Bi-polar square waves are also available from Amp 1 and Amp 2 outputs.

3.2.3 Procedure for producing positive square

A. Same settings as in 3.2.1 with exception of SQ AMP selector which should be POS.

B. Monitor Sq Amp output. A positive square is also available out of Amp 1, negative square from Amp 2.

3.2.4 Procedure for producing negative square.

A. Same settings as in 3.2.1 with exception of SQ AMP selector which should be NEG.

B. Monitor Sq Amp output. A negative square is also available out of Amp 1, positive square from Amp 2.

3.2.5 Procedure for prouducing bi-polar square pulses

A. Same settings as in 3.2.1 with exception of SYMMETRY switch which should be POS or NEG.

B. Monitor Sq Amp output. Bi-polar square pulse is also available from Amp 1 and Amp 2 outputs.

3.2.6 Procedure for producing positive square pulses

A. Same settings as in 3.2.1 with exception of SYMMETRY switch which should be POS or NEG and SQ AMP selector to POS.

B. Monitor Sq Amp output. Positive square pulse is also available from Amp 1 and Amp 2 outputs.

3.2.7 Procedure for producing negative square pulses

A. Same settings as in 3.2.1 with exception of SYMMETRY switch which should be POS or NEG and SQ AMP selector to NEG.

B. Monitor Sq Amp output. Negative square pulse is also available from Amp 1 and Amp 2 outputs.

3.2.8 Procedure for producing sine waveform

A. Same settings as in 3.2.1 with exception of Amp 1 and Amp 2 selectors which are set to SINE.

B. Monitor Amp 1 or Amp 2 output. Amp 2 sine will be 180° out of phase with Amp 1.

3.2.9 Procedure for producing triangle waveform

A. Same settings as in 3.2.1 with exception of Amp 1 and Amp 2 selectors which are set to TRIANGLE.

B. Monitor Amp 1 or Amp 2 output. Amp 2 triangle will be 180° out of phase with Amp 1.

3.2.10 Procedure for producing ramp waveforms

Same procedure and settings as in 3.2.9 A-B with exception of SYMMETRY switch which should be POS.

3.2.11 Procedure for producing reverse ramp waveform.

Same procedure and settings as in 3.2.9 A-B with exception of SYMMETRY switch which should be NEG.

3.2.12 Procedure for push-pull operation

Amp 1 and Amp 2 provide push-pull outputs automatically with individual amplitude controls. When Amp 2 is in Amp INV position, you would still have a push-pull output except that amplitudes of both amplifiers can be controlled by Amp 1 attenuator.

3.2.12 Procedure for push-pull operation (continued)

Amp 2 amplitude attenuator is used for balance. For example, if Amp 1 were set to Sine and Amp 2 set to Amp 1 INV, the unit will produce a push-pull sine output. Amp 1 produces sine at zero degrees while Amp 2 produces sine output at 180 degrees. The attenuator for Amp 2 is now used to match the amplitude of sine waveform out of Amp 1. Adjusting attenuator of Amp 1 will now control amplitude of both waveforms.

3.2.13 VCF Operation (Models 503 and 505 only)

A VCF Mode selector switch provides a selection of input voltages depending on what is available. They are 0 to +5V, 0 to -5V and 0 to ±2½. INPUT MUST MATCH VCF MODE SELECTOR. When used in conjunction with the sweep switch, the user has a choice of sweeps; he may sweep up in frequency or down in frequency, or up and down about a center frequency in the ±2½V position. Center frequency will be approximately one-half dial setting.

Sweep direction vs input voltage:

1. 0 to +5V position - With sweep switch in NORM position and a 0 to plus input voltage, generator will sweep from dial frequency down to low end of sweeping range set by expansion control. In INV position generator frequency will drop to 1/50th of dial setting, then sweep up to a frequency to a point set by expansion control. With expansion control fully CW, generator will sweep up to a dial frequency. The INV position requires an external frequency counter to determine exact frequency settings.

2. 0 to -5V position - With sweep switch to NORM the generator will initially drop to approximately 1/50th of dial setting with zero volts input. Precise frequency must be determined with an external frequency counter. When a 0 to minus voltage is applied, the generator will sweep up in frequency to an upper frequency which is set by expansion control. Again, an external frequency counter is required to determine upper frequency.

   With sweep switch to INV position, generator will sweep from dial setting down to a frequency set by the expansion control.

3.2.13 VCF Operation (continued)

3. 0 to ±2½V position - when VCF mode switch is set to ±2½V with zero volts input, the generator frequency will drop to approximately one-half of dial setting. With sweep switch set to NORM and a ramp input starting at -2½V, the generator will drop in frequency from the center frequency to the low end of the sweeping range, approximately 1/50th of dial setting. As ramp goes positive, generator frequency will increase at a linear rate until the input reaches the +2½V peak, at which time the generator will be at approximately dial setting. When the sweep switch is set to INV the reverse will happen. Exact frequency settings must be determined with an external counter.

3.2.14 Gating, triggering (single shot) 504 and 505

NOTE: LOCKOUT CIRCUITRY WILL NOT FUNCTION PROPERLY WHEN THE OFFSET SWITCH IS IN THE NEG POSITION.

A. Gating operation (D.C. coupled)

1. Switch mode selector to Gate.

2. Monitor any output.

3. Push manual Gate/Trig button and observe output continues as long as depressed.

4. Once button is released, observe that last cycle is completed before locking out.

5. Using external +5 volts feeding Ext gate input, observe that generator free runs as long as input is applied.

B. Trigger (single shot) operation (A.C. coupled)

1. Switch mode selector to Trig.

2. Monitor any output.

3. Push manual Gate/Trig button and observe that a single pulse is generated each time button is depressed.

4. Using external pulse source of +5 volts with a 1±sec risetime or faster, feed Ext input, observing that a single pulse is generated for each external trigger input pulse.

SECTION 4

CIRCUIT DESCRIPTION

4.0.0 . . . . . CIRCUIT DESCRIPTION AND THEORY

4.1.0 CIRCUIT DESCRIPTION

4.1.1 BLOCK DIAGRAM (refer to drawing 505-100, Section 7).

4.1.2 POWER SUPPLY

The regulated power supply produces all operating voltages required by the instrument. It includes regulated ±18V and unregulated ±30V. The power supply is short circuit protected.

4.1.3 INTEGRATOR

The purpose of the integrator is basically to integrate a square waveform into a linear triangle waveform.

4.1.4 X10 AMP

The X10 Amp is an operational amplifier with a gain variable from 10 to 1. The triangle from the integrator is passed through this amplifier.

This variable gain amplifier causes the triangle amplitude to vary, thus allowing the frequency to be changed.

4.1.5 LEVEL DETECTOR

The function of the Level Detector is to produce a square waveform which is used to connect the + and - VCF supply to the integrator to obtain the triangle waveform.

4.1.6 TIMING AND FEEDBACK CIRCUITRY

The purpose of the timing and feedback circuitry is to connect the integrator and level detector together to make a free-running generator producing square and triangle waveforms plus a method for varying the frequency simultaneously.

The timing circuitry connects the level detector to the integrator circuit. The combination of these circuits produces a free-running oscillator, producing a square waveform and a triangle waveform. The timing circuitry also provides a method of controlling and varying the frequency of the free-running oscillator circuit.

4.1.7 SINE SHAPER

The sine shaper is basically an amplifier utilizing the non-linear characteristics of semiconductor

4.1.7 SINE SHAPER (continued)

diodes to cause the amplifier gain to vary non-linearly. The triangle waveform is fed into the sine shaper and the resultant sine waveform is produced.

4.1.8 AMP 1 (non inverting)

Amp 1 is basically a high-gain, wide bandwidth amplifier with negative feedback.

Any of four inputs (square, triangle, sine or the output of the other amplifier) may be selected. The selected waveform is amplified and applied to the output.

The amplifier will drive 600 ohms at greater than 25V P-P and is short-circuit protected. Output amplitude will vary with load.

4.1.9 AMP 2

Amp 2 is essentially identical to Amp 1 but is inverting.

4.1.10 SQUARE AMPLIFIER

The square amplifier is basically an electronic switch. It is driven BY the square wave from the level detector. The use of such a circuit produces a good square wave with relatively fast rise and fall times.

Overshoot, ringing and droop are limited by peak clamping of both negative and positive extremes. This amplifier will drive a 600-ohm load at 25V P-P and a 50-ohm load at a lower amplitude. This amplifier is short circuit protected.

4.1.11 VCF AMPLIFIER

The purpose of the VCF Amp is to provide an equal positive and negative voltage which can be varied simultaneously by the application of an external VCF input voltage (voltage controlled frequency).

4.1.12 LOCKOUT AMPLIFIER

The purpose of the lockout amplifier is to enable the generator to lock out (stop running). Two lockout modes are provided, gate and trigger. In the gate mode, the generator can be externally or manually gated on as long as signal is applied. In

4.1.12 LOCKOUT AMPLIFIER (continued)

the trigger mode the generator will produce one complete cycle each time a signal is received.

4.2.0 CIRCUIT THEORY OF OPERATION

4.2.1 POWER SUPPLY (refer to drawing 505-103)

The power supply produces ±18V and ±30V to the instrument and consists of two basically identical series regulators which produce a low ripple ±18V from an unregulated ±30V source.

Line voltage is applied to transformer T100 through the ON/OFF switch S100 and fuse F100. The transformer produces 30 volts AC which is fed to rectifier assembly D100 which produces the unregulated ±30V. Capacitors C100 and C110 provide filtering of the unregulated +30V.

Because both the +18V and the -18V regulators are basically identical, only the positive regulator will be discussed here. Q100 is basically a current source. The maximum current is limited by resistor R101.

REGULATOR OPERATION (+18V supply)

A reference voltage of approximately +9V is applied to one side of differential amplifier Q160 and Q180. The reference zenerD162 is connected through D121 and voltage divider R123 and R122 to apply approximately +8V on C121 initially to provide a starting voltage for the regulator.

Q160 will supply current to the base of Q120 which will in turn supply voltage to the base of Q140.

Emitter follower Q140 supplies the regulated +18V. The emitter voltage of Q140 is fed through voltage divider R182, R183 and R184.

The arm of R183 is adjustable and provides approximately +9V at the base of Q180 when Q140 emitter voltage is +18V.

If the output voltage increases due to a decrease in load or an increase in line voltage, the base voltage at Q180 will increase, causing the collector current of Q160 to decrease. The base voltage of Q160 is fixed by zener diode D162 at approximately +9V.

With a decrease in collector current of Q160, voltage at the base of Q120 will increase, causing less collector current to flow through Q120 and R124,

REGULATOR OPERATION (continued)

lowering the voltage at the base of Q140 until the emitter voltage has returned to +18V.

+18V adjust is used to calibrate the power supply to +18V ±3mv. -18V supply operates in essentially the same manner.

4.2.2 INTEGRATOR (refer to drawing 505-101)

The integrator circuit is utilized to produce a very linear output triangle by integrating the square waveform produced by the level detector and the VCF amplifier. The integrator is an operational amplifier.

The operational amplifier Q230 has a matched FET input to obtain a very high input impedance.

Q200 and Q210, matched FET's, provide an extremely high input impedance into the operational amplifier. Feedback from the output emitter follower, Q250 and Q255, is accomplished through the integrating capacitors, C201 through C206, selected by the Decade switch and is also applied to the inverting side of the operational amplifier. This provides negative feedback, forcing the summing junction to remain at virtual ground. The Int Bal control is adjusted to balance the two inputs of the differential operational amplifier.

With the positive VCF supply connected to the timing resistor, the output of the operational amplifier will try to switch negative immediately.

The positive voltage applied to the timing resistor and connected to the summing junction will allow a finite current to flow through the timing resistor. This current will be constant as the VCF voltage is constant and the summing junction is held at virtual ground due to the extremely high gain and negative feedback. Due to the negative feedback through the integrating capacitor, output must charge the integrating capacitor.

As the timing current flows from the summing junction, an equal but opposite current will be applied through the integrating capacitor in the feedback loop. This feedback current through the integrating capacitor must remain constant as the input timing current is constant. This will cause the output to rise negative charging the capacitor at a constant rate.

4.2.2 INTEGRATOR (continued)

The output is connected to the level detector through the X10 Amp. When the X10 Amp output reaches a predetermined level, the level detector will change state and invert the square waveform applied to the switching bridge. This will in turn reverse the operation described and the integrator output will reverse and start rising positively, thus producing a linear triangle waveform at the output.

By switching in different timing resistors and integrating capacitors, frequency can be changed in decade steps. By varying the Multiplier dial, the triangle amplitude applied to the integrating capacitors is changed causing a linear change in timing current and thereby changing frequency. By switching resistors and capacitors with the Decade switch and adjusting the Multiplier dial, any desired frequency from 0.0001 to 1MHz may be obtained.

The Sym switch, S560, is provided to produce non-symmetrical operation required for the various non-symmetrical waveforms such as the ramp, reverse ramp and square waveform pulses. Switch S560 enables the VCF voltage to be connected directly to the summing junction, by-passing the timing resistor.

When S560 is switched to the negative position, R575 connects the applied negative VCF voltage directly to the summing junction.

When the positive VCF voltage is connected, the timing resistor will be by-passed by R575, a 10K resistor, causing a much larger timing current to flow. The output of the integrator will rise positive much faster as a result of the increased timing current.

When the output of the X10 Amp reaches the trip point of the level detector, the VCF supply will reverse polarity as previously described. With the negative VCF supply now connected, the integrator will integrate at the same rate as in the NORM position.

4.2.3 X10 AMP (refer to drawing 505-101)

The purpose of the X10 Amp is to vary the amplitude of the triangle waveform from the output of

4.2.3 X10 AMP (continued)

the integrator. The amplitude of the triangle waveform from the integrator determines the amount of time required to charge the feedback capacitor. If the amplitude of this triangle changes, the frequency will change.

The X10 Amp is composed of Q260, Q280 and Q290. Q260 is an operational amplifier with a fixed gain of approximately 10.

The output of the X10 Amp is fed through output emitter followers Q280 and Q290 to the input of the level detector. The triangle amplitude at the input of the level detector will remain constant as this is controlled by the level detector trip points.

R261 (multiplier) and R263 form a voltage divider to the input of the operational amplifier. With the arm of the Mult control set at maximum (X10), the triangle amp at the output of the Integrator will be minimum. A .4V P-P triangle would produce a 4V P-P triangle at the X10 Amp output.

With the Mult set at minimum (X1), approximately a 4V P-P triangle waveform will be required to drive the output of the X10 amplifier to 4V P-P. It takes much longer to charge the feedback capacitor to 4V P-P than to .4V P-P. In this manner, the Mult in conjunction with the X10 Amp varies the frequency of the generator manually.

4.2.4 LEVEL DETECTOR (refer to drawing 505-103)

The level detector is used in conjunction with the integrator to produce a free-running square and triangle waveform.

The input to the level detector is connected to the output of the X10 Amp. Q300 is a constant current source for differential amplifier Q310 and Q320. Q340 and Q350 form a second differential amplifier which is connected to Q310 and Q320 to form a high-gain amplifier circuit.

The output voltage swing of Q340 and Q350 collectors are both clamped by a diode bridge to approximately ±1.5V P-P.

Positive feedback is used to obtain very fast switching.

4.2.4 LEVEL DETECTOR (continued)

With the input rising positive, Q310 will turn off and Q320 will turn on. Once Q310 is turned off, the collector voltage of Q310 will go negative. This will in turn cause Q350 base to go negative, causing Q350 to turn off and Q340 to conduct harder. Q340 collector voltage will go farther negative, causing Q320 base to go negative and Q320 to conduct harder. Positive feedback Q350 collector voltage will increase due to Q350 turning off. This in turn causes the output to switch to its positive state.

A positive input waveform causes the output to switch positive when the input trip point is reached (inverting). In this manner, the integrator, X10 Amp and the level detector create a free-running square and triangle waveform simultaneously.

Q340 collector signal is applied to the output emitter follower which drives the square amplifier and produces the trigger out signal.

4.2.5 SINE SHAPER

The sine shaper is basically a differential operational amplifier with non-linear feedback which will produce a low-distortion sine wave from a linear triangle input.

Transistors Q600, Q610 and Q620, Q630 are two differential amplifiers connected together to form a high-gain amplifier.

With the input rising at a constant slope (positive triangle), Q630 collector voltage will go negative. As the output rises negatively, the feedback network voltage divider will essentially connect smaller and smaller resistance across the fixed gain feedback resistor R674, thus causing the gain to decrease as the output voltage rises negatively.

When the input triangle changes slope, the output will simply reverse polarity and rise positive, producing the same non-linear action. The constantly changing gain of the amplifier will produce the required sine waveform.

Q640 emitter follower and Q650 constant current source provide the necessary current to drive the feedback network. Q660 and Q670 emitter followers provide the moderately low output impedance to drive the associated circuitry.

4.2.6 SQUARE AMPLIFIER

The square amplifier is essentially a high-speed switch which produces a 28V P-P output square wave at less than 50 nanosecond rise and fall times.

The square wave from the level detector is fed into the square amplifier input. With the squarewave in its positive state, Q800 will turn on, causing Q800 collector to go negative. This negative signal at Q800 causes Q810 to saturate, thus pulling the collector voltage of Q810 positive very rapidly. The positive input signal will hold Q830 off as long as the input remains positive. When the input switches negative, Q840 collector will switch negative very rapidly.

This squarewave is applied through selector switch S810 to the output emitter follower.

4.2.7 SQUARE SELECTOR SWITCH S810

When switched to the POS SQ position, a diode is in series with the squarewave being applied to the output emitter follower. This will allow signal to pass in only one direction.

When the selector switch is placed in the NEG SQ position, only the negative portion of the square waveform will pass to the emitter follower and on to the output.

4.2.8 AMP 1 (non inverting)

Amp 1 provides the selected waveform at 28V P-P into 600 ohms at the output.

The signal is applied at the input to Amp 1 (TP900). A positive signal will cause Q900 to turn on, driving Q910 collector positive. This amplified signal is applied to output buffer Q920 and Q950 which drive Amp 1 output. The gain is fixed by R941 and R931 to approximately 3.

4.2.9 AMP 2 (inverting)

Amp 2 also provides the selected waveform at 28V P-P into 600 ohms at the output (inverted).

The signal is applied to the emitters of input transistors Q700 and Q730. Q700 and Q730 bases are gounded.

A positive signal will cause Q700 to turn off.

4.2.9 AMP 2 (continued)

This will cause Q710 to turn off driving the output negative. This signal is applied to the output buffer Q720 and Q750 which drive the output of Amp 2.

The gain is fixed at approximately 3 as in Amp 1.

4.2.10 VCF AMP

The VCF Amp provides a ± voltage to the timing resistors which can be varied causing the frequency to change.

Q500 differential amplifier is connected to Q540 to form the positive VCF supply amplifier. Q530 is a constant current source for Q500. With Q500 output base grounded, a positive signal at Q500 input base will cause Q508 input transistor to turn on, driving Q540 base negative and the output positive. Negative feedback (R544, R547) fixes the gain at about 4.

With the input grounded, the output will be approximately 500mv. With a +5V signal at the input, the output will be at +16V. The negative supply is composed of transistors Q550, Q560 and Q580.

A voltage divider (R562, R563 and R581) is connected from the +16V supply to the -16V supply. Base of Q560 will set at about zero volts due to the voltage divider. +16V supply will cause Q560 to turn off driving Q580 base negative, driving output of Q580 negative. When the output reaches -16V, voltage at the base of Q560 will reach zero volts and thus maintain the negative supply at -16V as long as +16V supply remains at +16V. In this manner, the negative supply will track the positive supply and always provide an equal but opposite voltage.

As VCF input voltage varies from zero volts to +5V, VCF supply voltages will vary from ±16V to approximately ±500mv.

The VCF mode switch provides three different modes of operation so that the user may operate the VCF with virtually any signal input.

4.2.11 LOCKOUT AMPLIFIER

The lockout amplifier is composed of Q400, Q410, Q420, Q430, Q440, Q450 and Q460.

4.2.11 LOCKOUT AMPLIFIER (continued)

The output of the integrator (TP250) is connected to the input of differential amplifier Q460 and Q450. The base of Q450 is connected to ground through R443 (1K).

The summing junction of the integrator is connected to the collector of Q450 through a pair of diodes (D452, D453).

If the two diodes become forward biased, they will prevent any further timing current at the summing junction, thus causing the integrator to stop integrating.

The collector of Q450 must reach approximately +1V or greater to lock out the generator.

The signal at Q460 base is the triangle waveform from the integrator output. The triangle at this point will vary from approximately ±400mv P-P to ±4V P-P.

Q440 provides offset to Q450 base preventing lockout when in the Run mode of operation. In the Run mode, +18V is applied at Q400 base. Q400 will turn on, which in turn turns on Q440 driving the base of Q450 positive, preventing lockout.

When in the Gate mode of operation, the input of Q400 is connected to the EXT input jack.

With no signal applied at Q400 base, Q400 will turn off, which in turn causes the base of Q450 to return to ground potential. Now the generator will lock out as the triangle rises positive, turning off Q460, thus turning on Q450 and forward biasing the lockout diodes.

An input voltage of approximately +5V or greater applied at the EXT input jack will cause the generator to free run as previously explained as long as the signal is applied.

The generator can be turned on manually by depressing the manual pushbutton switch, applying +18V to the input. The generator will continue to run as long as the pushbutton is depressed.

When the Mode switch is placed in the Trig position, the input becomes AC coupled.

A positive signal applied at the input will cause

4.2.11 LOCKOUT AMPLIFIER (continued)

Q400 to turn as previously described. The Multi-action of Q410, Q420 and Q430 will cause Q410 to turn on and remain on until a positive signal is applied at Q430 base allowing Q410 to turn off and the generator to lock out.

The timing square wave is in the Neg position (-16V supply connected) when the generator locks out. The generator will lock out when the triangle rises to zero volts.

Q400 turning on will allow the generator to start running again as previously described. The triangle will continue rising positive until the positive trip point is reached at the level detector input.

The timing square will now reverse polarity (positive) and connect the +16V supply, thus reversing action. The triangle now integrates negatively until the negative trip point is reached. The -16V is again connected, causing the triangle to integrate positive.

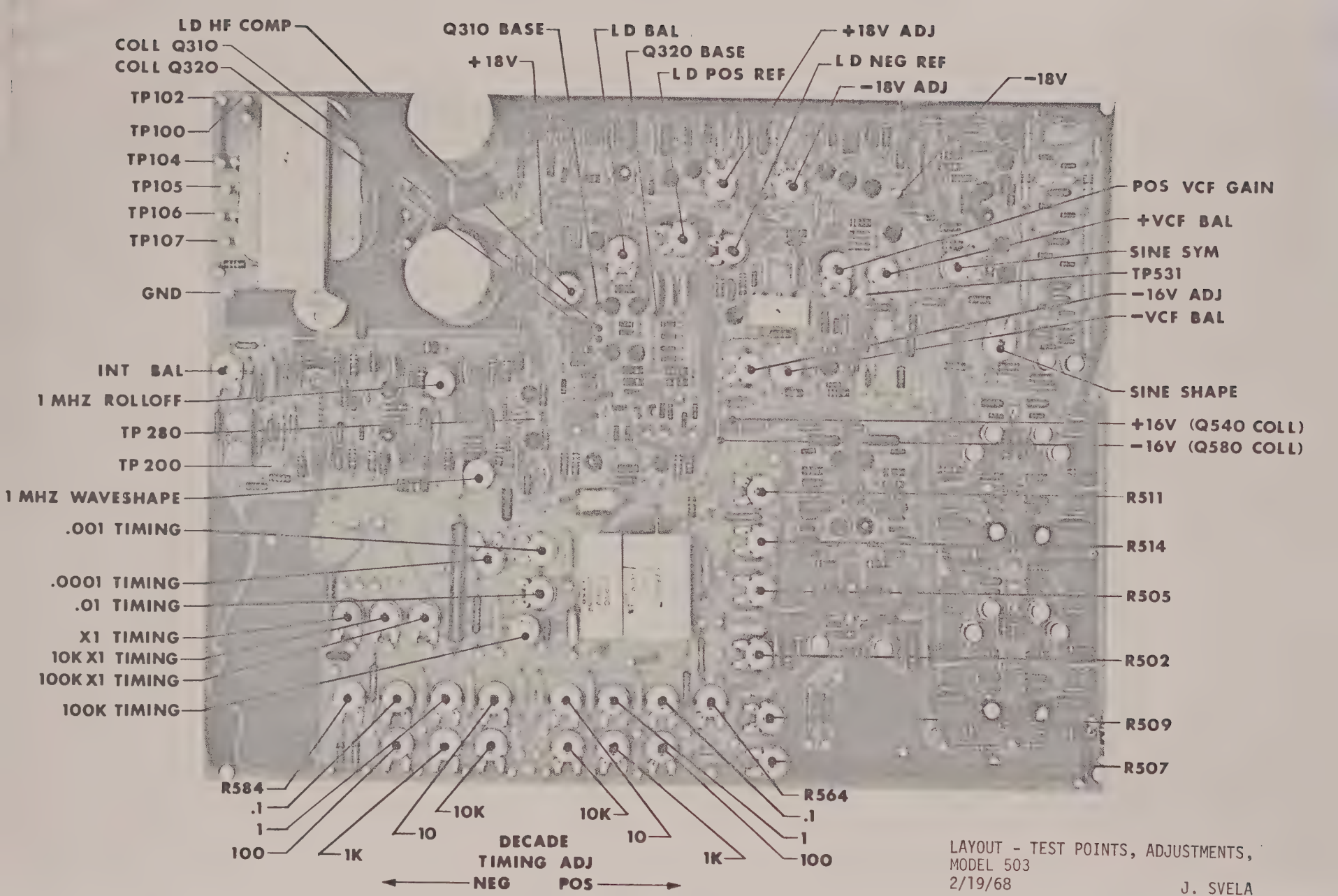
When the timing square switched negative, the square wave at Q360, Q370 switched positive (inverted).

This square wave is connected to Q430 base through C431, a 68pf capacitor. A positive pulse will turn Q430 on and Q410 off, thus placing the lock-out amplifier in a lockout condition. When the triangle reaches zero volts, lockout will occur. Thus, one complete cycle is generated each time a pulse is applied at the EXT input jack or the manual pushbutton is depressed.

NOTE: INPUT PULSE RISETIME MUST BE 100nsec OR FASTER.

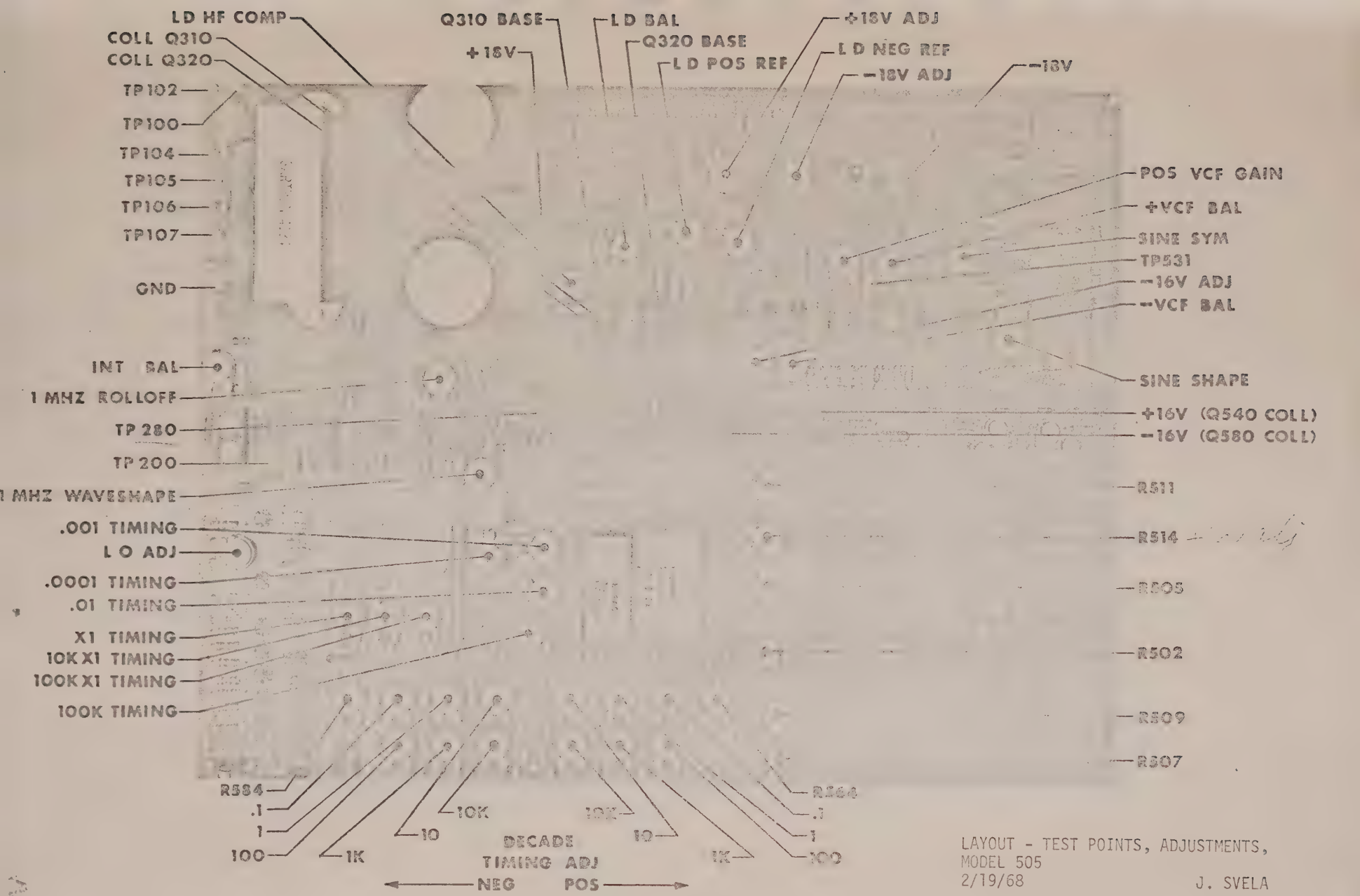
SECTION 5

CALIBRATION



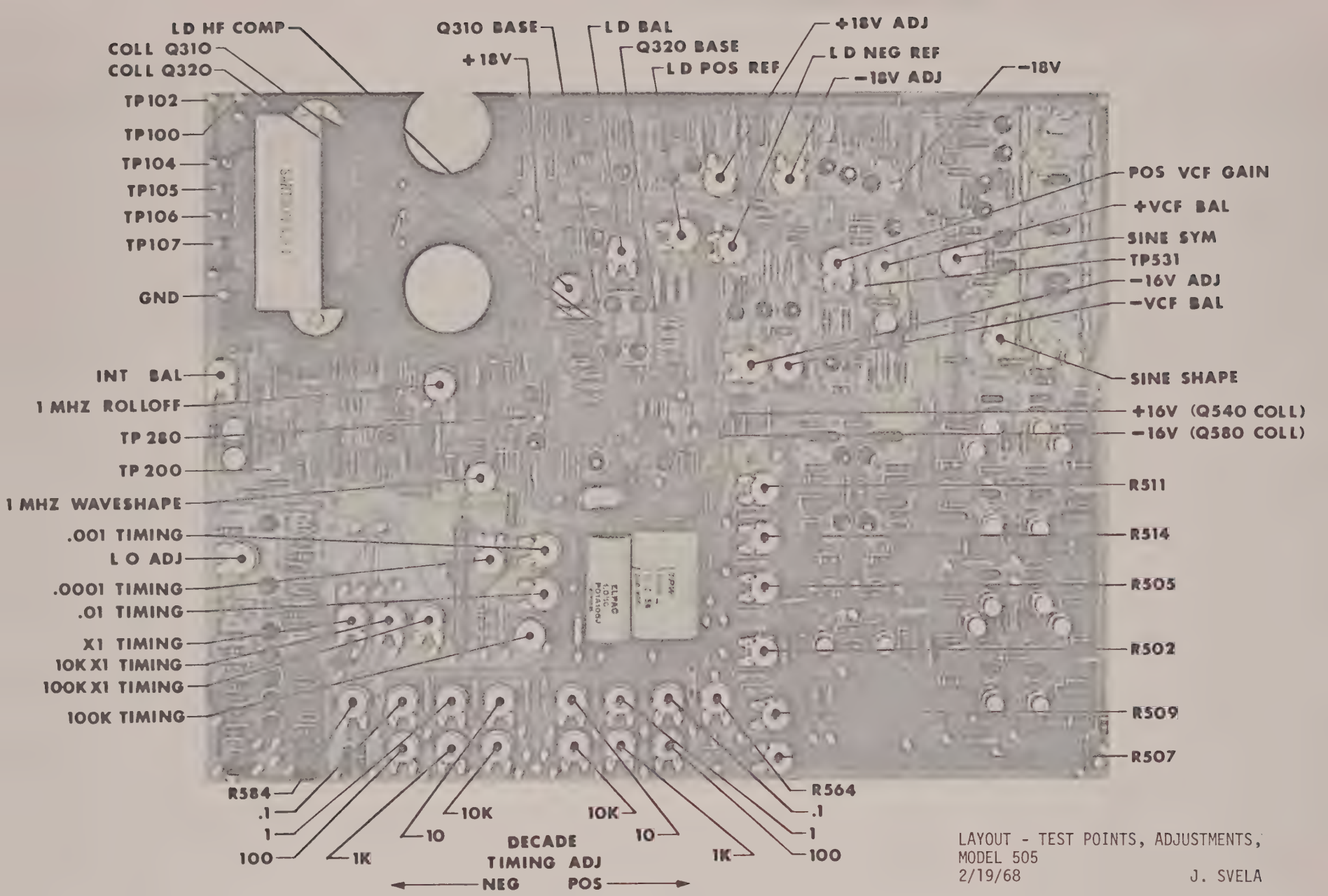
LAYOUT - TEST POINTS, ADJUSTMENTS,
MODEL 503
2/19/68

J. SVELA



LAYOUT - TEST POINTS, ADJUSTMENTS,
MODEL 505
2/19/68

J. SVELA



LAYOUT - TEST POINTS, ADJUSTMENTS,
MODEL 505
2/19/68 J. SVELA

5.0.0 . . . . . CALIBRATION AND MAINTENANCE

5.1.0 FAILURE TO OPERATE

Read operating instructions to insure a thorough understanding of all front panel controls.

Should instrument fail to have an output from any of three amplifier outputs, check the following.

A. Unplug instrument and check 117V 3AG 1/2 amp fuse, or 3AG 1/4 amp for 220V operation, located on rear panel.

B. Remove cover and check for 117V AC between TP100 and 102. This checks power line cord.

Measure between TP104 and 107 for 117V AC. This check is for power on/off switch and associated wire. It insures that power is going into power transformer.

If trouble is not located in above steps, follow calibration procedure until trouble is located.

5.2.0 FAILURE TO MEET FACTORY SPECIFICATIONS

Check the following.

A. Proper operating instructions in Section 3 to insure a thorough understanding of all front panel controls.

B. Perform all steps of calibration procedure. If instrument still does not meet specifications, contact factory and arrange to return for a complete check-out and evaluation.

5.3.0 CALIBRATION PROCEDURE

The following test equipment or suitable equivalents of known accuracy are required for complete calibration of the Types 503, 504 and 505 function generators.

A. Oscilloscope, DC to 100MHz, Tektronix 547 with 1A1 plug-in.

B. Distortion Analyzer, Hewlett Packard 333A.

C. Variac Powerstat

D. Constant voltage DC source accurate to 1mv.

E. Frequency Counter, CMC 607A.

F. Differential voltmeter, Medistor A-50.

5.3.0 CALIBRATION PROCEDURE (test equipment continued)

G. VOM, Simpson 260

H. 600-ohm purely resistive load

NOTE: Calibration procedure applies to Models 503, 504, and 505 unless otherwise indicated.

5.3.1 POWER SUPPLY

NOTE: Instrument should be ON for at least thirty minutes before any of the following adjustments is made.

A. +18-volt calibration

1. Connect differential voltmeter to +18V test point.

2. Adjust +18V ADJ to obtain +18V ±2mv.

B. -18-volt calibration

1. Connect differential voltmeter to -18V test point.

2. Adjust -18V ADJ to obtain -18V ±2mv.

C. Line regulation check

1. Connect differential voltmeter to +18V test point.

2. Using Variac, vary line voltage from 105V to 125V while monitoring supply voltage. Supply voltage should remain constant ±10mv.

3. Connect differential voltmeter to -18V test point.

4. Using Variac, vary line voltage from 105V to 125V while observing -18V supply voltage. Supply voltage should remain constant ±10mv as in step 2.

D. Power supply ripple check

Set oscilloscope controls as follows

VERTICAL SENSITIVITY	MAX
INPUT COUPLING	AC
SWEEP TIME	10MSEC/CM
TRIGGER	LINE

5.3.1 D. (continued)

Measure 120Hz ripple content of the +18V and -18V supplies.

Ripple on each supply should be less than 5mv.

5.3.2 INTEGRATOR BALANCE

A. Using a short jumper lead, connect test point TP~~280~~ 288 to nearest ground test point.

B. Connect a VOM to test point TP280.

C. Adjust INT BAL ADJ to obtain zero volts.

D. Remove jumper.

5.3.3 LEVEL DETECTOR BALANCE

A. Using short jumper leads, connect the base of transistors Q310 and Q320 to nearest ground.

B. Adjust L.D. BAL ADJ to obtain equal voltages ±50mv at the collectors of Q310 and Q320 (approximately -5V). Measure with VOM.

C. Remove jumpers.

5.3.4 LEVEL DETECTOR POSITIVE AND NEGATIVE REFERENCE ADJ

A. Set oscilloscope controls as follows, using a differential plug-in such as Tektronix Type W or equivalent.

VERT	MAX SENSITIVITY DIFFERENTIAL MODE
INPUT COUPLING	DC
SWEEP TIMING	.1MSEC/CM
TRIGGER	EXT POS
monitor test point 280	

B. Set function generator controls as follows

MODE	RUN
MULTIPLIER	X10
DECADE	1K
OFFSET	NORM
SYMMETRY	NORM
VCF MODE	OFF
SWEEP	NORM

C. Adjust L.D. POS REF ADJ until the positive peak of the triangle is +4 volts ±10mv as observed on oscilloscope.

5.3.4 (continued)

C. Adjust L.D. NEG REF ADJ until the negative peak of the triangle is -4 volts ±10mv as observed on oscilloscope.

5.3.5 ±16V ADJUST (Model 504)

Adjust R562 (+16V) and R582 (-16V) to obtain ±16V ±3mv.

5.3.6 VCF PRELIMINARY ADJUSTMENT (503 and 505 only)

A. Set function generator controls as follows.

MODE	RUN
MULTIPLIER	10
DECADE	100
OFFSET	NORM
SYMMETRY	NORM
VCF MODE	OFF
SWEEP	NORM

B. Using a jumper lead, connect TP531 to nearest ground.

C. Connect a voltmeter to the collector of Q540 (+16V).

D. Adjust the POS VCF BAL ADJ to obtain zero volt.

E. Remove jumper lead.

F. Set VCF GAIN ADJ and -VCF BAL ADJ to mid range.

G. Adjust +16V ADJ (R514) to obtain +16V ±3mv at Q540 collector (+16V).

H. Connect the differential voltmeter to the collector of Q580.

J. Adjust the -16V ADJ to obtain -16V ±3mv.

K. Set controls as follows

VCF MODE	0 to +5V
SWEEP	INV
EXPANSION	FULL CW
INPUT VOLTAGE	GND

L. Adjust -VCF BAL ADJ to obtain equal voltages ±2mv at Q580 and Q540 collectors (+16V and -16V supplies). Use a differential voltmeter to measure these voltages of approximately 300mv.

5.3.6 (continued)

M. Set controls as follows.

VCF MODE	OFF
SWEEP	NORM

Repeat steps G through L.

5.3.7 MULTIPLIER DIAL ADJUST

A. Set controls as follows

MODE	RUN
DECADE	100
OFFSET	NORM
SYMMETRY	NORM
VCF MODE	OFF
SWEEP	NORM

B. Remove multiplier dial control and rotate multiplier control shaft full CCW.

C. Monitor generator frequency using a frequency counter at square amp out.

D. Rotate multiplier control shaft CW until the frequency has increased approximately 5%.

E. Replace multiplier dial carefully without moving multiplier control shaft. Align the "1" on the dial skirt directly in line with index mark on the front panel. Tighten both set screws, being careful not to move multiplier control shaft.

F. With multiplier set on 10, adjust 100 TIMING ADJ controls to obtain a frequency of 1KHz ±.5% and symmetrical ±.5%.

G. Set MULT to 1.

H. Adjust 100 x 1 ADJ to obtain 100Hz ±.5%.

J. Set Multiplier on 10.

5.3.8 TIMING

A. Set controls as follows.

MODE	RUN
DECADE	1K
MULTIPLIER	10
OFFSET	NORM
SYMMETRY	NORM
VCF MODE	OFF

5.3.8 TIMING (continued)

NOTE: Steps 5.3.1 through 5.3.7 must be completed before final timing is started.

B. Connect frequency counter to monitor generator frequency at square amp output.

C. Adjust decade range timing adjustments (two per decade) to obtain the following frequencies as read on frequency counter.

Decade	Adj	To Obtain	Symmetry
1K	1K timing adj	10KHz ±.5%	±.5%
100	100 "	1KHz ±.5%	±.5%
10	10 "	100KHz±.5%	±.5%
1	1 "	10Hz ±.5%	±.5%
.1	.1 "	1Hz ±.5%	±.5%
*.01	.01 "	.1Hz ±.5%	
*.001	.001 "	.01Hz ±.5%	
*.0001	.0001 "	.001Hz±.5%	

* NOTE: Adjust R584 and R564 to obtain correct symmetry ±.5% before adjusting timing on lower three decades.

D. Set Multiplier to X1 and check all decade positions checked for correct frequency and symmetry as stated in specifications.

E. Set decade to 100K and multiplier to 10.

F. Set oscilloscope as follows.

VERTICAL SENSITIVITY	2V/CM
INPUT COUPLING	DC
SWEEP TIMING	.2MSEC/CM
TRIGGERING	EXT

Monitor TP280, X10 amp output

Adjust 1MHz ROLLOFF trimmer capacitor to obtain optimum triangle waveform, free of oscillations.

G. Adjust 1MHz WAVESHAPE trimmer capacitor to obtain optimum triangle waveform linearity.

H. Adjust L.D.H.F. COMP trimmer capacitor to obtain an 8V P-P ±20mv triangle waveform.

5.3.8 TIMING (continued)

J. Adjust 100K TIMING ADJ trimmer capacitor to obtain 1MHz ±.5%.

K. Repeat steps D through J.

L. Set multiplier to 1 and adjust 10K x 1 ADJ to obtain 100KHz ±.5%.

M. Set decade on 10K and multiplier on X10.

N. Adjust 10K TIMING ADJ controls to obtain 100KHz ±.5% and symmetrical ±.5%.

P. Set multiplier to X1 and adjust 10K X 1 ADJ to obtain 10KHz ±.5%.

5.3.9 VCF MODE CALIBRATE (Models 503 and 505 only)

A. 0 to +5V mode
Set controls as follows

MODE	RUN
DECADE	1K
MULT	10
VCF MODE	0 to +5V
SWEEP	NORM
VCF INPUT VOLTAGE	+5V ±2mv*

*NOTE: VCF input voltage must be constantly monitored with a differential voltmeter as loading, etc., can effect the input voltage.

1. Connect frequency counter to monitor generator output frequency.

2. Adjust VCF expansion control (front panel) to obtain 200Hz ±1% as read on counter.

NOTE: VCF input voltage may have to be readjusted until correct frequency and input voltage are attained simultaneously.

3. Set SWEEP to INV. Readjust +5V ±3mv at input if necessary. Do not move expansion control.

4. Adjust R507 until the generator frequency is 10KHz ±.5%.

5.3.9 (continued)

B. 0 to ±2.5V mode

Set controls as follows

VCF MODE	0 to ±2.5V
SWEEP	NORMAL
EXPANSION	FULL CW
INPUT VOLTAGE	0 V (gnd)

1. Adjust R505 to obtain frequency of 5KHz ±.5%.

2. Set SWEEP switch to INV position. The frequency should be 5% to 15% higher than in Step 2 (no adjustment).

3. Apply +2.5V ±3mv at VCF input.

4. Adjust VCF expansion control to obtain 200Hz ±1%.

5. Apply -2.5V ±3mv at VCF input. The frequency should be 10KHz ±2% (no adjustment).

6. Set SWEEP to INV.

7. Apply -2.5V ±3mv at VCF input.

8. Adjust VCF EXPANSION control to obtain 200Hz ±1%.

9. Apply +2.5V ±3mv at VCF input. The frequency should be 10KHz ±5% (no adjustment).

C. 0 to -5V mode

Set controls as follows.

VCF MODE	0 to -5V
SWEEP	INV
EXPANSION	FULL CW
INPUT VOLTAGE	0 V (gnd)

1. Adjust R509 to obtain 10KHz ±.5%

2. Apply -5V ±3mv at VCF input.

3. Adjust R502 to obtain 200Hz ±1%.

4. Set SWEEP to NORM position.

5. Adjust R511 to obtain 200Hz ±1%.

6. Apply -5V ±3mv at VCF input. The frequency should be 10KHz ±10% (no adjustment).

5.3.10 SQUARE AMP

No calibration required.

5.3.11 AMP 1

No calibration required unless circuit component is changed. R935 is selected at factory to obtain approximately 250mv to 500mv voltage drop across R942 as measured with a VOM.

5.3.12 AMP 2

No calibration required unless circuit component is changed. R705 is selected at factory to obtain approximately 250mv to 500mv voltage drop across R742 as measured with a VOM.

5.3.13 SYMMETRY MODES

NOTE: No adjustment necessary

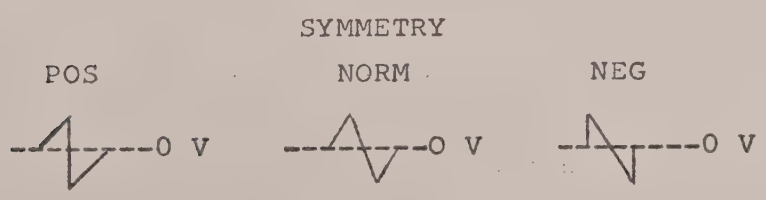
Set function generator controls as follows.

MODE	RUN
MULTIPLIER	10
DECADE	1K
SYMMETRY	NORM
OFFSET	NORM
VCF MODE	OFF
AMP 1	TRIANGLE
AMP 1 ATTENUATOR	MAX

Set oscilloscope controls as follows.

VERTICAL SENSITIVITY	5V/CM
INPUT COUPLING	DC
SWEEP TIME	10μSEC
TRIGGER	EXT POS
Monitor Amp 1 output	

The following waveforms should be observed, depending upon the position of the symmetry switch.



5.3.14 OFFSET MODES

NOTE: no adjustment necessary

Set oscilloscope and generator controls as in 5.3.12.

The following waveforms should be observed, depending upon the position of the offset switch.

5.3.15 SINE SHAPER

A. Set generator controls as follows.

MODE	RUN
DECADE	100
MULTIPLIER	10
SYMMETRY	NORM
OFFSET	NORM
VCF MODE	OFF
AMP 1	SINE
AMP 1 ATTENUATOR	MAX

B. Set oscilloscope as follows.

VERTICAL SENSITIVITY	5V/CM
INPUT COUPLING	DC
SWEEP TIME	.2MSEC
TRIGGER	EXT POS

Monitor Amp 1 output

C. Connect a distortion analyzer to Amp 1 output.

D. While observing waveform, adjust the SINE SHAPE and SINE SYM to obtain minimum distortion as indicated on distortion analyzer. Distortion should be less than .7%.

5.3.16 LOCKOUT AMP

NOTE: Lockout will not operate properly when the offset switch is in the negative position.

A. Set generator controls as follows.

5.3.16 LOCKOUT AMP ("A" continued)

MODE	GATE
DECADE	100
MULTIPLIER	10
SYMMETRY	NORM
OFFSET	NORM
VCF MODE	OFF
AMP 1	TRIANGLE POS
AMP 1 ATTENUATOR	MAX

B. Set oscilloscope controls as follows.

VERTICAL SENSITIVITY	5V/CM
INPUT COUPLING	DC
SWEEP TIME	.2MSEC
TRIGGER	EXT POS
Monitor TP280	

C. Connect VOM to TP280.

D. Adjust L.O. ADJ to obtain 0V ±20mv.

E. Depress manual Gate/Trig button to insure that generator free runs as long as button is depressed.

F. Switch Mode selector to Trig. Check to insure that a single pulse is generated at all outputs each time the manual Gate/Trig button is depressed. Scope triggering is very sensitive and critical in monitoring single pulse.

G. Using external voltage feeding external input, check to insure that gate function operates with a minimum of +4V input. Do not exceed 20V input or damage to the instrument may occur.

H. Using external square pulse with 100nsec rise-time or faster feeding external input, check trig function to insure that a single pulse is generated at all outputs for each input pulse of #3 volts or greater. Do not exceed 20V input voltage.

J. The operation of the gate and trigger mode is explained fully in the first time operation section.

5.3.17

Monitor trigger output and check for a .7V P differentiated square wave. No calibration required.

SECTION 6

PARTS LIST

R - resistors
C - capacitors
D - diodes
Q - transistors
SW - switches
T - transformers
F - fuses
P - pilot light

Parts are listed according to function in the instrument. However they are also in numerical order by 100, 200 etc series numbers so it is not necessary to know the function.

POWER SUPPLY

R100	68K	301-683
R101	5.6K	301-562
R111	8.2K	301-822
R121	1.6K	301-162
R122	12K	301-123
R123	4.3K	301-432
R124	9.1K	301-912
R131	7.5K	301-752
R132	1.6K	301-162
R141	100Ω 7W	308-205
R142	100Ω	301-101
R143	1K	301-102
R144	845Ω 1%	310-124
R151	100Ω	301-101
R152	150Ω 7W	308-206
R161	649Ω 1%	310-686
R171	15K	301-153
R172	20K	301-203
R173	1K	301-102
R181	2.7K	301-272
R182	8.2K	301-822
R183	1K pot	311-102
R184	4.32K 1%	310-693
R185	2.49K 1%	310-103
R186	4.99K 1%	310-566
R187	4.32K 1%	310-693
R191	7.5K	301-752
R192	200Ω MTC4	311-100
R193	7.5K 1%	310-649

C100	2500mf 35V	290-034
C110	2500mf 35V	290-034
C121	10mf 20V	290-031
C141	270pf	281-540
C161	10mv 20V	290-031
C171	270pf	281-540
C181	.01	283-005
C182	10mf 20V	290-031
C190	.01	283-005

D100	MDA920A-3	152-051
D101	1N4001	152-050
D110	1N4001	152-050
D121	1N914	152-028
D161	1N914	152-028
D162	1N935A	152-048
D181	1N4001	152-050
D191	1N4001	152-050

Q100	5193	156-5193
Q110	5190	156-5190
Q120	2N4121	156-043
Q130	MPS6543	156-050
Q140	5190	156-5190
Q150	5193	156-5193
Q160	MPS6543	156-050
Q170	2N4121	156-043
Q180	MPS6543	156-050
Q190	2N4121	156-043

F100	1/2A Slo Blo	136-003

DS100	Alco BNF-2	

T100	Sartron 4184	120-030

X10 AMP (cont)

C261	10mf 20V	290-031
C262	3-12pf	281-036
C263	47pf	281-532
C264	.01	283-005
C265	7pf	281-536
C266	470pf	281-539
C267	.01	283-005
C268	3-12pf	281-036
C269	7pf	281-536
C270	10mf 20V	290-031
C280	.01	283-005
C281	.001	283-000
C291	.001	283-000
C292	.01	283-005

D261	1N914	152-028
D262	1N914	152-028
D263	1ZM12T5 12V	152-022
D264	1ZM12T5 12V	152-022
D281	1N914	152-028
D291	1N914	152-028

Q260	CA3030 RCA	157-008
Q280	MPS6543	156-050
Q290	2N4121	156-043

LEVEL DETECTOR

R301	12.1K ¼W 1%	313-1212
R302	1.8K	301-182
R303	100Ω MTC4	311-099
R304	3.01K ¼W 1%	313-3011
R311	1K 1%	310-605
R312	442Ω 1%	313-4420
R313	3.65K ¼W 1%	313-3651
R315	100Ω MTC4	311-099
R321	402Ω 1%	310-662
R323	3.65K ¼W 1%	313-3651
R324	500Ω MTC4	311-057
R325	4.75K 1%	310-599
R326	4.75K 1%	310-599
R327	500Ω MTC4	311-057
R341	2.7K	301-272
R342	10Ω	301-100
R351	2.7K	301-272
R352	10Ω	301-100
R353	1K	301-102
R361	150	301-151
R362	4.7K	301-472
R363	15	301-150
R364	180	301-181
R371	15	301-150
R372	4.7K	301-472
R373	150	301-151

C301	10mf 20V	290-031
C311	8-50pf	281-022
C312	68pf	281-523
C361	.001	283-000
C362	22pf	281-530
C371	.001	283-000

D311	1N914	152-0914
D312	1N914	152-0914
D321	1N914	152-0914
D322	1N914	152-0914
D323	1N914	152-0914
D324	1N914	152-0914
D341	1N914	152-0914
D342	1N914	152-0914
D343	1N914	152-0914
D345	1N914	152-0914
D350	1N914	152-0914
D351	1N914	152-0914
D352	1N914	152-0914
D353	1N914	152-0914
D354	1N914	152-0914
D355	1N914	152-0914
D356	1N914	152-0914
D357	1N752	152-031
D358	1N752	152-031
D359	TI55	152-009
D361	1N914	152-0914
D362	1N914	152-0914
D363	1N914	152-0914
D371	1N914	152-0914

Q300	2N4121	156-043
Q310	*2N4250 matched	-4250
Q320	*2N4250 matched	-4250
Q340	MPS 6543	156-050
Q350	MPS 6543	156-050
Q360	MPS 6543	156-050
Q370	2N4121	156-043

LOCKOUT

R401	1.5K	301-152
R402	2.7K	301-272
R403	10K	301-103
R404	10K	301-103
R405	10K	301-103
R411	33K	301-333
R412	3.3K	301-332
R413	10K	301-103
R421	33K	301-333
R422	3.3K	301-332
R423	10K	301-103
R431	12K	301-123
R432	1K	301-102
R433	2.2K	301-222
R441	3.3K	301-332
R442	1.8K	301-182
R443	1K 1%	310-605
R444	15K	301-153
R451	13K 1%	310-674
R452	1K MTC4	311-102
R453	13K 1%	310-674
R454	1K 1%	310-605
R455	10K	301-103
R460	3.3K	301-332
R461	10K	301-103

C401	7pf	281-536
C402	100pf	281-537
C403	47pf	281-532
C431	68pf	281-542
C451	12pf	281-543

D401	1N914	152-028
D402	1N914	152-028
D403	1N914	152-028
D441	1N914	152-028
D442	1N914	152-028
D443	1N914	152-028
D451	1N914	152-028
D452	CD1541	152-010
D453	1N914	152-028
D461	1N914	152-028
D462	1N914	152-028

Q400	MPS6543	156-050
Q410	MPS6543	156-050
Q420	MPS6543	156-050
Q430	MPS6543	156-050
Q440	2N4121	156-043
Q450	*2N4250 matched	157-4250
Q460	*2N4250 matched	157-4250

VCF AMP

R501	24.9K 1%	310-139
R502	5K pot MTC4	311-103
R503	19.1K 1%	310-1912
R504	71.5K 1%	310-131
R505	10K	301-103
R506	14.3K 1%	310-127
R507	1K pot MTC4	311-102
R508	35.7K 1%	310-130
R509	5K pot MTC4	311-103
R510	1.75M 1%	310-141
R511	3.5M pot MTC4	311-106
R512	71.5K 1%	310-131
R513	36.5K 1%	310-3652
R514	2K pot MTC4	311-115
R516	10K 1%	310-600
R517	82	301-820
R518	6.81K 1%	310-671
R519	820	301-821
R520	6.19K 1%	310-767
R521	5.62K 1%	310-126
R522	100Ω	301-101
R523	6.8M	301-685
R531	100Ω pot MTC4	311-099
R532	4.7K	301-472
R533	10K	301-103
R534	5.6K	301-562
R541	6.8M	301-685
R542	47	301-470
R543	270	301-271
R544	31.6K 1%	310-766
R545	10K	301-103
R546	1.5M	301-155
R547	1K pot MTC4	311-102
R551	6.81K 1%	310-671
R552	7.5K	301-752

VCF AMP (cont)

R553	100Ω pot MTC4	311-099
R554	100Ω	301-101
R555	6.19K 1%	310-767
R556	820Ω	301-821
R561	5.62K 1%	310-126
R562	14K 1%	310-112
R563	1K pot MTC4	311-102
R564	10K pot	311-109
R565	8.45M 1%	309-266
R566	845K 1%	310-133
R567	84.5K 1%	310-8452
R568	3.5M pot MTC4	311-106
R569	100K pot MTC4	311-110
R570	10K pot MTC4	311-109
R571	100K pot MTC4	311-110
R572	10K pot MTC4	311-109
R573	10K pot MTC4	311-109
R574	28K 1%	310-129
R575	10K	301-103
R581	14K 1%	310-112
R582	270Ω	301-821
R583	47Ω	301-470
R584	10K pot MTC4	311-109
R585	10K	301-103
R586	3.5M pot MTC4	311-106
R587	100K pot MTC4	311-110
R588	10K pot MTC4	311-109
R589	100K pot MTC4	311-110
R590	10K pot MTC4	311-109
R591	10K pot MTC4	311-109
R592	28K 1%	310-129
R593	84.5K 1%	310-132
R594	8.45M 1%	309-266
R595	845K 1%	310-133
R596	10K	301-103

C501	270pf	281-540
C541	68pf	281-542
C542	22pf	281-530
C543	.01	283-005
C551	.01	283-005
C581	68pf	281-542

D501	1N752 5.6V	152-031
D541	1N914	152-028
D542	1N914	152-028
D561	1N752 5.6V	152-031
D581	1N914	152-028

Q500	2N4045	156-054
Q530	MPS6543	156-050
Q540	2N4121	156-043
Q550	*2N4121 matched	157-4121
Q560	*2N4121 matched	157-4121
Q580	MPS6543	156-050

SINE SHAPER

R600	3.92K ¼W 1%	313-3921
R601	100Ω pot	311-099
R602	1.21K ¼W 1%	313-1211
R610	3.92K ¼W 1%	313-3921
R611	1K	301-102
R612	100Ω	30 .-101
R613	100Ω MTC4	311-099
R614	3.9K	301-392
R620	910Ω	301-911
R621	150	301-151
R622	3K	301-302
R630	150Ω	301-151
R631	3K	301-302
R640	47Ω	301-470
R641	121Ω 1%	310-557
R642	221Ω 1%	310-648
R643	267Ω 1%	310-120
R644	100Ω	301-101
R650	750Ω	301-751
R651	1K	301-102
R652	121Ω 1%	310-557
R653	825Ω 1%	310-647
R654	221Ω 1%	310-648
R655	3.32K 1%	310-122
R656	267Ω 1%	310-120
R660	475Ω 1%	310-118
R661	562Ω 1%	310-5620
R662	100Ω	301-101
R663	15Ω	301-150
R664	30Ω	301-390
R665	33Ω	301-330
R670	3.92K 1%	310-123
R671	475Ω 1%	310-118
R672	8.25K 1%	310-604
R673	562Ω 1%	310-663
R674	2.21K 1%	310-607
R675	15Ω	301-150
R676	100	301-101
R677	82	301-820

SQUARE AMP (cont)

R824	1.2K	301-122
R825	1.8K	301-182
R831	150	301-151
R832	1.3K	301-132
R833	2.7K	301-272
R834	2.2K	301-222
R841	1.2K	301-122
R842	12K	301-123
R843	47Ω	301-470
R844	10K	301-103
R851	1K pot atten	311-102
R852	15	301-150
R853	120Ω 1W	303-121
R854	4.7K	301-472

C801	10mf 20V	290-031
C802	22pf	281-530
C811	10mf 20V	290-031
C821	.001	283-000
C822	.05	283-010
C823	7pf	281-536
C824	.05	283-010
C831	10mf 20V	290-031
C832	22pf	281-530
C841	10mf 20V	290-031
C851	.001	283-000
C854	.05	283-010
C852	7pf	281-536
C853	.05	283-010

D801	1N914	152-028
D802	1N753A 6.3V	152-003
D811	1N914	152-028
D812	TI55	152-009
D813	1N914	152-028
D821	1N914	152-028
D831	1N914	152-028
D832	1N753A 6.3V	152-003
D840	1N914	152-028
D841	TI55	152-009
D842	1N914	152-028
D851	1N914	152-028

Q800	MPS6543	156-050
Q810	2N4121	156-043
Q820	2N2219	156-017
Q830	2N4121	156-043
Q840	MPS6543	156-050
Q850	2N2905	156-019

AMP 1

R901	5.62K 1%	310-126
R902	619Ω 1%	310-765
R903	1K pot	311-112
R904	22Ω	301-220
R911	47Ω	301-470
R912	100Ω	301-101
R921	5.62K 1%	310-126
R922	220Ω 2W	305-221
R923	22Ω	301-220
R924	1.2K	301-122
R931	22Ω	301-220
R932	619Ω 1%	310-765
R933	5.62K 1%	310-126
R934	360Ω	310-361
R935	*selected on initial calibration	
R941	910Ω	301-911
R942	100	301-101
R943	47Ω	301-470
R951	22Ω	301-220
R952	5.62K 1%	310-126
R953	220 2W	305-221
R954	20K pot 10-turn Beckman Helitrim	311-320
R955	2.7K	301-272

C901	1mf 50V	290-001
C921	1mf 50V	290-001
C922	.05	283-010
C923	6.8mf 35V	290-042
C931	1mf 50V	290-001
C951	1mf 50V	290-001
C952	.05	283-010
C953	6.8mf 35V	290-042

D901	1N914 selected.	152-052
D921	1N914 selected	152-052
D931	1N914 selected	152-052
D951	1N914 selected	152-052

Q900	2n2219	156-017
Q910	2N2905	156-019
Q920	2N2219	156-017
Q930	2N2905	156-019
Q940	2N2219	156-017
Q950	2N2905	156-019

SQUARE AMP (cont)

R824	1.2K	301-122
R825	1.8K	301-182
R831	150	301-151
R832	1.3K	301-132
R833	2.7K	301-272
R834	2.2K	301-222
R841	1.2K	301-122
R842	12K	301-123
R843	47Ω	301-470
R844	10K	301-103
R851	1K pot atten	311-102
R852	15	301-150
R853	120Ω 1W	303-121
R854	4.7K	301-472

C801	10mf 20V	290-031
C802	22pf	281-530
C811	10mf 20V	290-031
C821	.001	283-000
C822	.05	283-010
C823	7pf	281-536
C824	.05	283-010
C831	10mf 20V	290-031
C832	22pf	281-530
C841	10mf 20V	290-031
C851	.001	283-000
C854	.05	283-010
C852	7pf	281-536
C853	.05	283-010

D801	1N914	152-028
D802	1N753A 6.3V	152-003
D811	1N914	152-028
D812	TI55	152-009
D813	1N914	152-028
D821	1N914	152-028
D831	1N914	152-028
D832	1N753A 6.3V	152-003
D840	1N914	152-028
D841	TI55	152-009
D842	1N914	152-028
D851	1N914	152-028

Q800	MPS6543	156-050
Q810	2N4121	156-043
Q820	2N2219	156-017
Q830	2N4121	156-043
Q840	MPS6543	156-050
Q850	2N2905	156-019

AMP 1

R901	5.62K 1%	310-126
R902	619Ω 1%	310-765
R903	1K pot	311-112
R904	22Ω	301-220
R911	47Ω	301-470
R912	100Ω	301-101
R921	5.62K 1%	310-126
R922	220Ω 2W	305-221
R923	22Ω	301-220
R924	1.2K	301-122
R931	22Ω	301-220
R932	619Ω 1%	310-765
R933	5.62K 1%	310-126
R934	360Ω	310-361
R935	*selected on initial calibration	
R941	910Ω	301-911
R942	100	301-101
R943	47Ω	301-470
R951	22Ω	301-220
R952	5.62K 1%	310-126
R953	220 2W	305-221
R954	20K pot 10-turn Beckman Helitrim	311-320
R955	2.7K	301-272

C901	1mf 50V	290-001
C921	1mf 50V	290-001
C922	.05	283-010
C923	6.8mf 35V	290-042
C931	1mf 50V	290-001
C951	1mf 50V	290-001
C952	.05	283-010
C953	6.8mf 35V	290-042

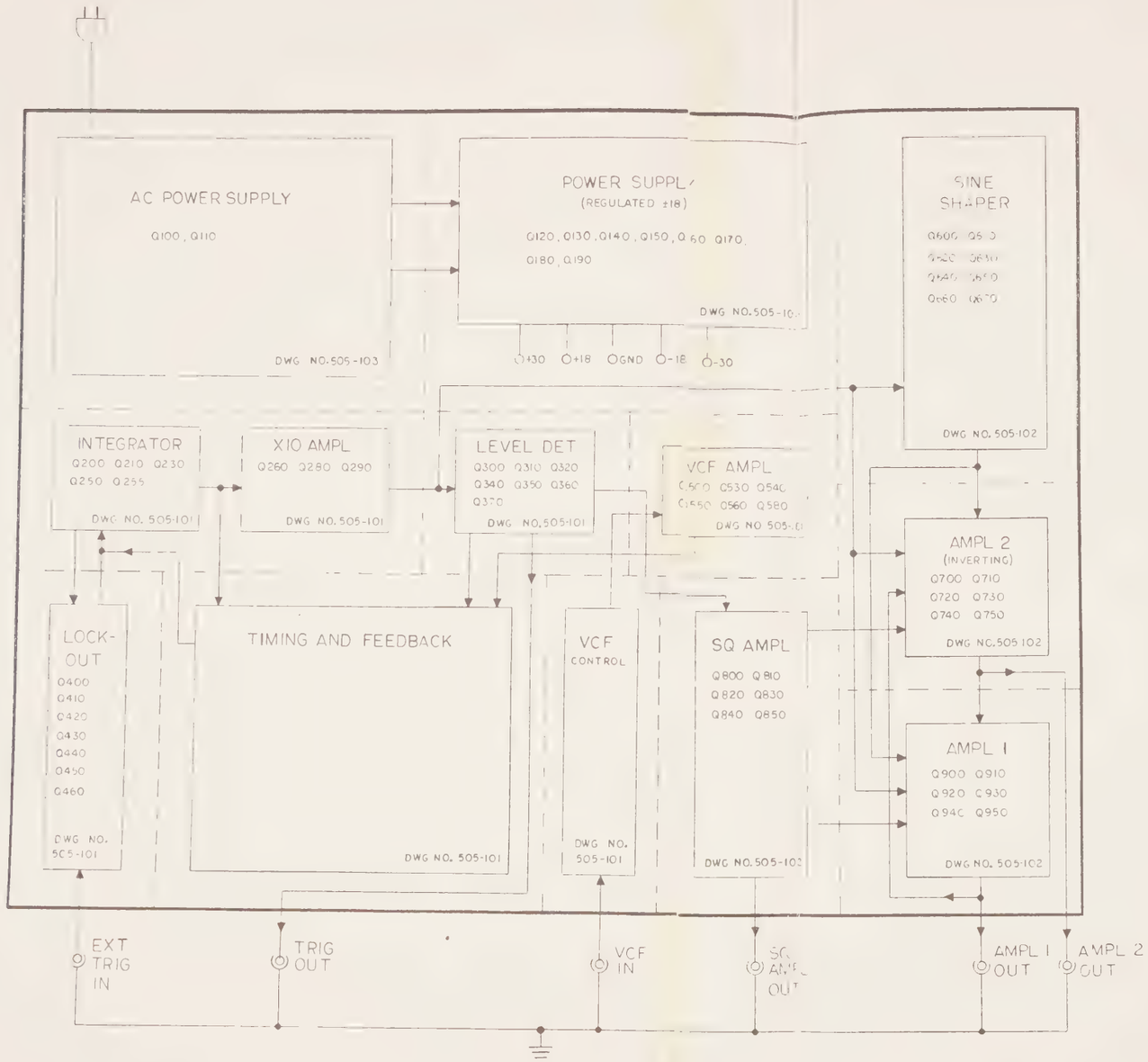
D901	1N914 selected	152-052
D921	1N914 selected	152-052
D931	1N914 selected	152-052
D951	1N914 selected	152-052

Q900	2n2219	156-017
Q910	2N2905	156-019
Q920	2N2219	156-017
Q930	2N2905	156-019
Q940	2N2219	156-017
Q950	2N2905	156-019

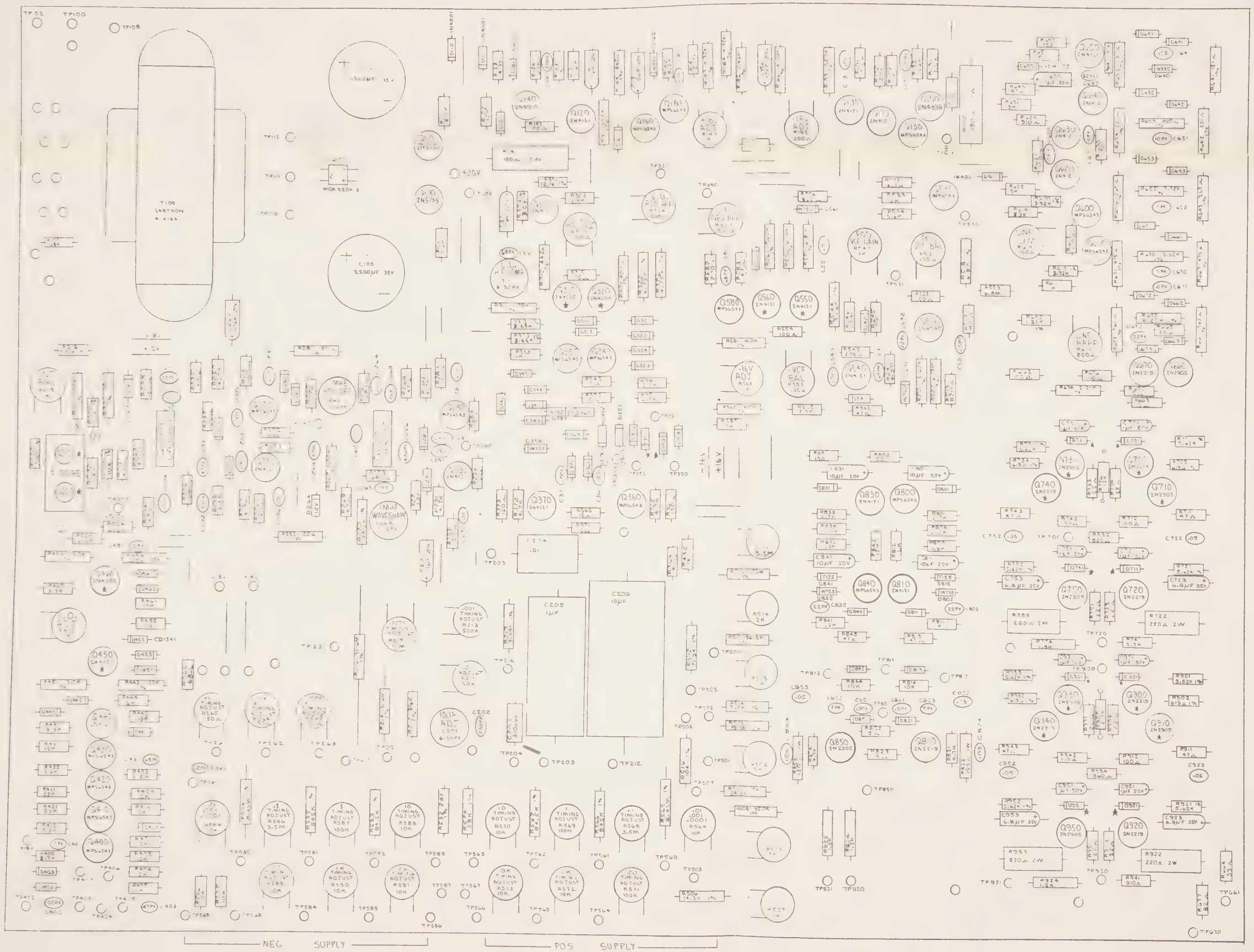
SECTION 7

CIRCUIT DIAGRAMS

DATE	BY	REVISION RECORD	AUTH	DR	CK

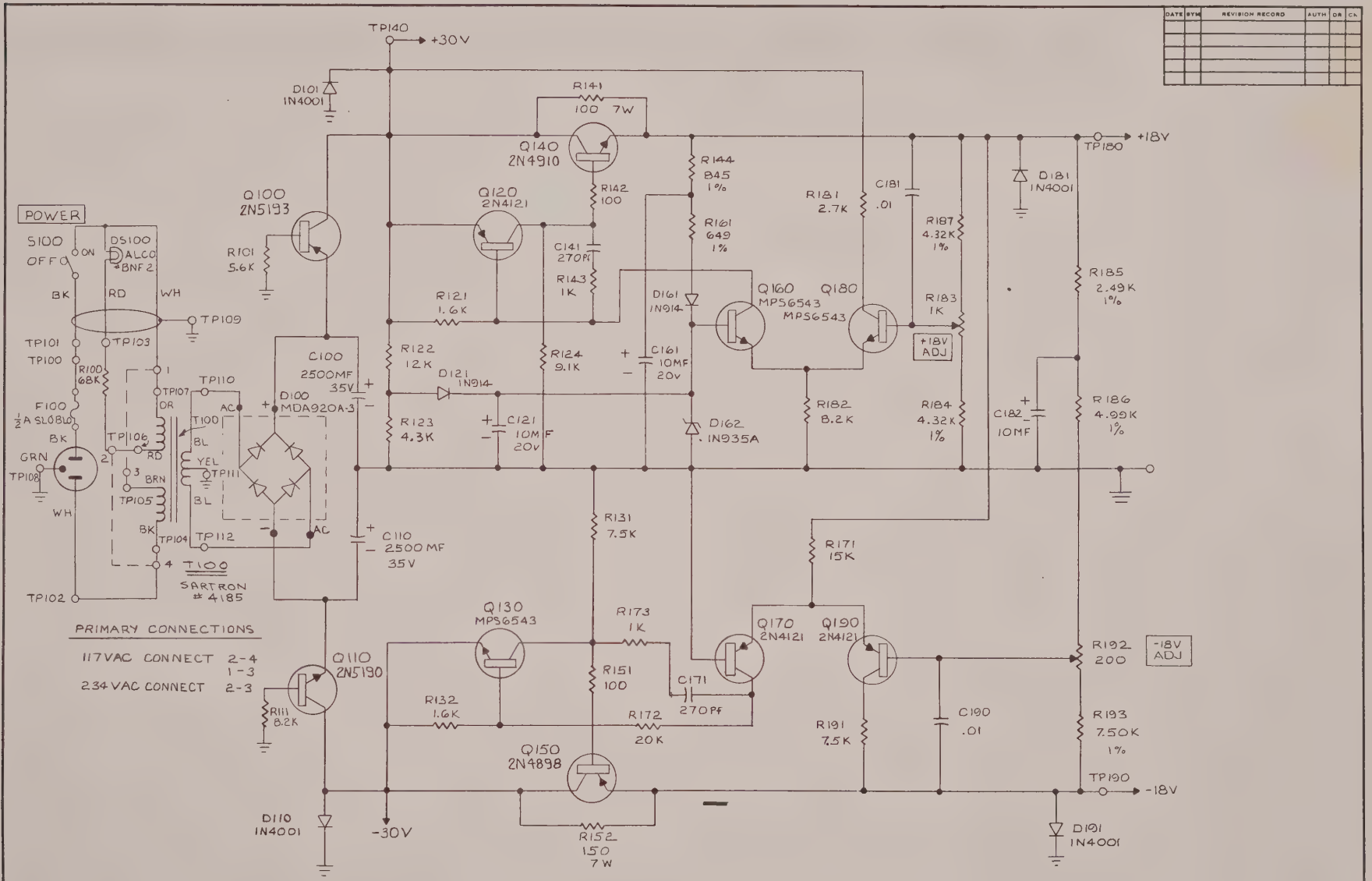


TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE	DRAWN BY [illegible] APPROVED BY
FRACTIONAL ±	TITLE BLOCK DIAGRAM MODEL 505		
ANGULAR ±	DATE 17NOV67	DRAWING NUMBER 505-100	



NOTES: Unless otherwise Indicated
1. ALL DIODES IN914
2. ★ INDICATES SELECTED COMPONENT

ASSEMBLY - P.C. BOARD, MODEL 505
505-200



DATE	BY	REVISION RECORD	AUTH	DR	CK

3) ALL CAPACITORS MARKED IN MF UNLESS OTHERWISE NOTED
2 ALL RESISTORS ARE 1/2W 5% UNLESS OTHERWISE NOTED
1 ALL RESISTORS MARKED IN OHMS
NOTES:

TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE	DRAWN BY JE / APPROVED BY
FRACTIONAL ±	TITLE SCHEMATIC – POWER SUPPLY, MODEL 505		
ANGULAR ±	DATE 3-15-68	DRAWING NUMBER 505-103	

K+E ALBANENE © 10 6480

DATE	BY	REVISION RECORD	AUTH	DR	CK

SINE SHAPER

TRI IN FROM R284 DWG 505-101 (REF)

SINE SHAPE

R602 1.21K 1% R601 200Ω

SINE SYM

R613 100 R615 100

Q600 MPSG543 Q610 MPSG543

R614 3.9K R616 1K

R620 910Ω

R621 150 R622 3K R630 150 R631 3K

C630 10PF C640 82PF

Q620 2N4121 Q630 2N4121

R640 47 R644 100Ω

Q640 2N4121

D640 IN935A 9V

C641 .05

R641 121 1% R642 221 1% R643 267 1% R660 475 1% R661 562 1%

D641 IN914 D642 IN914 D643 IN914 D661 IN914 D662 IN914 D663 IN914

D651 IN914 D652 IN914 D653 IN914 D671 IN914 D672 IN914 D673 IN914

R652 121 1% R654 221 1% R656 267 1% R671 475 1% R673 562 1%

R663 33Ω

C651 10PF R653 825 1% C652 10PF R655 3.32K 1% C670 10PF R670 3.92K 1% C671 10PF R672 8.25K 1% R674 2.21K 1%

R660 3.92K 1/4W 1% R610 3.92K 1/4W 1%

D650 IZM11T5 11V C650 10MF 20V R651 1K R650 750

Q650 2N4121

R662 100 R664 29 R667 1.5 R676 1100 R677 82

Q660 2N2905 Q670 2N2219

C672 22PF

+18 -18

SQUARE AMPLIFIER

SQ IN FROM R363 DWG 505-101 (REF)

C801 10MF 20V R801 2.7K R804 2.2K R811 1K R812 12K R813 47

D801 IN914 D802 IN753 6.2V D811 IN914 D812 T155

C802 22PF

Q800 MPSG543 Q810 2N4121

R803 1.8K R802 150

R831 150 R832 1.3K R833 2.7K R834 2.2K R841 1.2K R842 12K R843 47

Q830 2N4121 Q840 MPSG543

D831 IN914 D832 IN753 6.2V D840 IN914 D841 T155

C811 10MF 20V C831 10MF 20V C832 22PF C841 10MF 20V

SQ AMPL NORM POS 1, NEG

R821 4.7K R822 120 1W R823 15 R824 1.2K R825 1.8K R844 10K R854 4.7K R852 15 R853 120 1W

C821 .001 C823 7PF C824 .05 C851 .001 C852 7PF C853 .05 C854 .05

Q820 2N2905 Q850 2N2905

D813 IN914 D821 IN914 D842 IN914 D851 IN914

R814 10K

S810 R851 1K

TP810 TP811 TP812 TP851 ATTEN

TP850 J821 SQ OUT

TP820 TP821

AMPLIFIER 2 INVERTING

TP660 TP661 TP670

S700 R702 1K ATTEN

TRI SINE SQ AMPL 1 INV. AMPL 2

R701 1.62K 1% R703 619Ω 1% R711 47 R721 5.62K 1% R722 220 2W C722 .05 C723 6.8MF 35V

Q700 2N2219 Q710 2N2905 Q720 2N2219

C701 1MF 50V C721 1MF 50V C731 1MF 50V C741 1MF 50V C751 1MF 50V

D701 IN914 D711 IN914 D731 IN914 D741 IN914

R704 22 R712 100 R723 22 R732 820 R733 22 R742 100 R751 22 R754 1.8K

R731 5.62K 1% R734 619Ω 1% R743 47 R752 5.62K 1% R753 220 2W C752 .05 C753 6.8MF 35V

Q730 2N2905 Q740 2N2219 Q750 2N2905

+18V +30V -18V -30V

TP720 TP721 AMPL. 2 OUTPUT J721

R756 12K R755 20K OFFSETT +18V -18V

AMPLIFIER 1

S900 ATTEN R903 1K R935 TRI SINE AMP 2 AMPL 1

R901 1.62K 1% R902 619Ω 1% R911 47 R921 5.62K 1% R922 220 2W C922 .05 C923 6.8MF 35V

Q900 2N2219 Q910 2N2905 Q920 2N2219

C901 1MF 50V C921 1MF 50V C931 1MF 50V C941 1MF 50V C951 1MF 50V

D901 IN914 D911 IN914 D931 IN914 D941 IN914

R904 22 R912 100 R923 22 R932 820 R933 22 R942 100 R951 22

R931 5.62K 1% R934 619Ω 1% R943 47 R952 5.62K 1% R953 220 2W C952 .05 C953 6.8MF 35V

Q930 2N2905 Q940 2N2219 Q950 2N2905

+18V +30V -18V -30V

TP920 TP921 AMPL. 1 OUTPUT J921

R924 1.2K R955 2.7K R954 20K OFFSETT +18V -18V

4) ★ DENOTES SELECTED COMPONENT

3) CAPACITOR VALUES MARKED IN MF UNLESS OTHERWISE NOTED

2) RESISTOR VALUES MARKED IN OHMS

1) MPSG543 BOTTOM VIEW (B E C)

NOTES:

TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE	DRAWN BY APPROVED BY
FRACTIONAL ±	TITLE SCHEMATIC - SINE SHAPER, SQ AMPL AMPL 1, AMPL 2		
ANGULAR ±	DATE 4-13-68	DRAWING NUMBER 505-102	

DATE	BY	REVISION RECORD	AUTH	DR	CK

DECADE

S200

PART OF S200

INTEGRATOR

X10 AMPL

LEVEL DET

TRIG OUT

VCF INPUT

EXT MODE

MAN

LOCK OUT

SWEEP

S500

S500 REAR VIEW

S501

VCF MODE

VCF CONTROL

VCF AMPL

TIMING RESISTORS

NOT USED

5) F5085 BOTTOM VIEW

4) 2N4045 BOTTOM VIEW

3) MPS6543 BOTTOM VIEW

2) RESISTORS MARKED IN OHMS

1) CAPACITORS MARKED IN MF UNLESS NOTED OTHER WISE

NOTES

TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE	DRAWN BY
			APPROVED BY
FRACTIONAL ±	TITLE SCHEMATIC - INTEGRATOR, LEVEL DET, VCF, And LOCKOUT		
ANGULAR ± .	DATE 3-26-68	DRAWING NUMBER 505 - 101	

DATE	BY	REVISION RECORD	AUTH	DR	CR

INTEGRATOR

X10 AMPL

LEVEL DET

LOCK OUT

TIMING RESISTORS

EXT MODE

MAN

TRIG OUT

LOCKOUT

TRI OUT TO R602 DWG 505-102 (REF)

TO LOCKOUT R432 (REF)

FROM LEVEL DET R364 (REF)

PART OF S200

MATCHED F5085

MATCHED 2N4250

CA3030

MPS6543

2N4121

2N4045

IZM12T5

IN914

IN752

IN4454

NORM POS NEG

SYM

+16V ADJ

-16V ADJ

7 EA TIMING ADJ +

7 EA TIMING ADJ -

LEVEL DET ADJ

LO LEVEL ADJ

MATCH

OFFSET

+REF ADJ

-REF ADJ

INT BAL

.1 ADJ

.01 ADJ

.001 ADJ

.0001 ADJ

MULT

ROUTER ADJ

5) F5085 BOTTOM VIEW

4) 2N4045 BOTTOM VIEW

3) MPS6543 BOTTOM VIEW

2) RESISTORS MARKED IN OHMS

1) CAPACITORS MARKED IN MF UNLESS NOTED OTHER WISE

NOTES

TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE	DRAWN BY
			APPROVED BY
FRACTIONAL ±	TITLE SCHEMATIC - INTEGRATOR, LEVEL DET. And LOCKOUT		
ANGULAR ±	DATE 3-26-68	DRAW NO NUMBER 503-101	

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

DECADE

S200

FREQ IN Hz

INTEGRATOR

X10 AMPL

PART OF S200

LEVEL DET

TRIG OUT

SQ OUT

TO R602 DWG 505-102 (REF)

TO LOCKOUT R432 (REF)

TRI OUT TO R602 DWG 505-102 (REF)

MATCHED F 5085

MATCHED 2N4250

MATCHED 2N4121

MATCHED

MPS6543

CA3030

.01 ADJ

.001 ADJ

.0001 ADJ

INT. BAL

MULT

INPUT COMP

ROLLOFF ADJ

+REF ADJ

-REF ADJ

LEVEL DET BAL ADJ

LO ME ADJ

-VCF BAL ADJ

-VCF TRACK ADJ

7 EA TIMING ADJ +

7 EA TIMING ADJ -

+VCF BAL ADJ

+VCF GAIN ADJ

VCF INPUT

S500 REAR VIEW

SWEEP

S500

EXPANSION R515

S501

VCF MODE

0 to +5

0 to +2.5

0 to -5V

OFF

NOT USED

VCF CONTROL

VCF AMPL

TIMING RESISTORS

NORM POS NEG

SYM

5) F5085 BOTTOM VIEW — CUT LEAD

4) 2N4045 BOTTOM VIEW

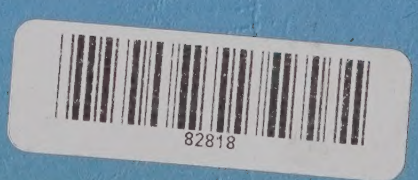
3) MPS6543 BOTTOM VIEW

2) RESISTORS MARKED IN OHMS

1) CAPACITORS MARKED IN MF UNLESS NOTED OTHER WISE

NOTES

TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE	DRAWN BY / APPROVED BY
FRACTIONAL ±	TITLE SCHEMATIC - INTEGRATOR, LEVEL DET, VCF, And LOCKOUT		
ANGULAR ±	DATE 3-26-68	DRAWING NUMBER 504-101	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